increased approximately linearly with the CPT voltage.

The appreciable differences observed experimentally in the behavior of various lines show that the rise time of the excitation pulse, as expected, plays a decisive role in the creation of inversion in transitions in which the lifetime of the upper level is low. The fact that the 4057 Å line is the first to appear indicates that this line has the largest gain. On the other hand, the differences in the dependence of the output power of various lines on the voltage can be attributed to the increase of the slope of the leading front of the pulse with increasing voltage, and to competition of the transitions.

In conclusion we note that the obtained new generation lines can serve as a basis for developing pulsed lasers having good characteristics. The large limiting efficiency gives hope for reaching efficiencies on the order of several per cent in the visible and ultraviolet regions. The gain at these lines is very high, making it possible to develop systems with small dimensions. The possibility of going from one line to another by changing the current rise time or simply the voltage of the CPT is also of interest. All this makes a lead-vapor laser a good companion to lasers using copper [8] and thallium vapor [6]. Lead, however, has also certain advantages. It permits generation on several lines in different regions of the spectrum. There is a readily available even isotope having no hyperfine structure. On the other hand, it is possible to work with it at a lower temperature than in copper, a very important practical consideration.

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MIXED SURFACE STATE OF A SUPERCONDUCTOR OF THE FIRST KIND

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In an analysis of various models of intermediate-state structures, L. D. Landau pointed out the possible occurrence, on the surface of a metal, of a thin layer in which the superconducting (s) and normal (n) state are so closely "intermixed," that a certain new state is produced, which he called "mixed." It is known that the proposed [1, 2] existence of a mixed state on the surface of samples placed in a constant magnetic field was not verified (see [3 - 5]).

There is, however, another possibility noted by Landau [6] for the occurrence of the mixed state, in the case when the destruction of the superconductivity is produced by a current flowing through the sample, while the magnetic field on the considered section of the surface remains lower than the critical field H_c. Such conditions arise, for example, in the case of a hollow cylinder with a current I flowing in the direction of its axis. In this case the field is zero inside the cavity and remains small also in the metal itself near the internal surface of the cylinder. In view of this, the normal state of the metal at $T < T_c$ should be unstable here even when I greatly exceeds the critical value I_c at which the field on the outer surface equals H_c. On the other hand, when $I > I_c$ the sample has resistance and therefore no continuous s-layer can be produced along the internal surface. It can be assumed that a thin layer (on the order of 10^{-4} cm) of the mixed state is produced on the surface, and should have a rather high conductivity, for in order that the metal adjacent to the layer to be in the n-state the surface density of the current in the layer must be not less than $cH_c/4\pi$ (if we neglect the influence of the electric field and of the current on the properties of the normal phase). In this case, if part of the volume of the cylinder is occupied by the intermediate state, s-regions can emerge to the internal surface, whereas the domains of the n-phase can be covered by layers of the mixed state.

It must be noted however that the hypothesis advanced in [6] may not be feasible, like the hypothesis of [1, 2], if this model is unstable. For example, the destruction of the layer in some spot, leading to a redistribution of the current, to a loss of the axial symmetry, and to the appearance of a transverse field in the aperture, might progress under the influence of this field; this would lead to the formation of an ordinary intermediate state on the internal surface.

To clarify these questions, we initiated experimental investigation of the state of a hollow single-crystal cylinder cast from indium with $R(300^\circ K)/R(\quad ^\circ K) = 1.6 \times 10^4$, with diameters $d_1 = 5.65$ and $d_2 = 3.15$ mm, and with length 32 mm. The lead current conductors soldered to the ends of the cylinder were axially symmetrical and did not distort the field near the cylinder. The current I through the sample was produced by a superconducting generator with rotating magnets, working on the "flux pumping" principle [7]. Owing to the symmetrical construction of the generator, the voltage produced with it was sufficiently constant.

To obtain the current-voltage characteristics of the sample V(I), potential leads spaced 10 mm apart were connected to the central part of the cylinder. The V(I) characteristics at 1.39 and 3.6°K are shown in Fig. 1 (curves 1 and 2). Knowing the conductivity of the sample material in the n-state, we can determine from these data the current flowing in the surface layers. These calculations are made difficult, however, by the noticeable dependence of the resistance of the employed indium on the temperature and on the magnetic field of the measuring current. We therefore obtained the V(I) characteristics for temperatures somewhat higher than T_c, making it possible to extrapolate these data with sufficient accuracy to $T = 3.16^\circ K$ and to plot the voltage against the current flowing through the n-phase (curve 3 on Fig. 1). The difference between the abscissas of curves 2 and 3 should thus be the current flowing in the surface layer; within the limits of the experimental accuracy, this current was independent of I up to $I = 10I_c$, and amounted to 25 - 30 A, as against the calculated value $I_c = (d_2/d_1) = 26$ A. The existence of an appreciable surface current close in magnitude to $I_c = (d_2/d_1)$ follows from the form of the V(I) curves also at lower temperatures (curve 1).

To obtain information on the state of the internal surface of the cylinder, we welded to

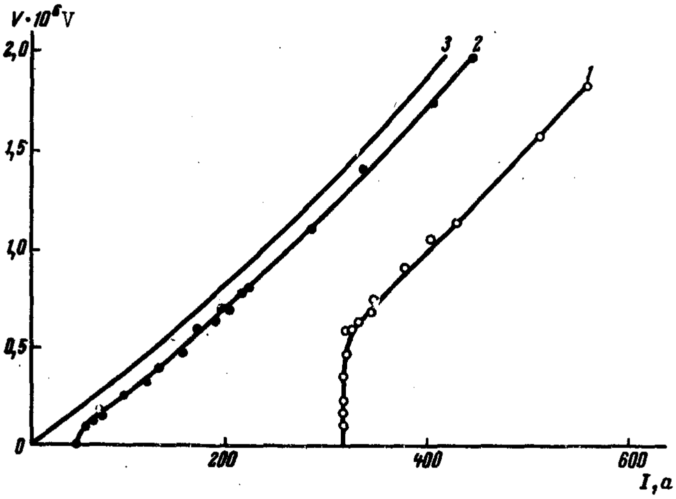

Fig. 1

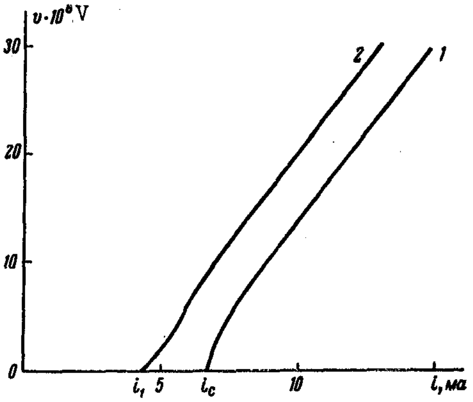

Fig. 2. Current-voltage characteristics of niobium contact (obtained with PDSO-21 automatic plotter), $T = 3.02°K$. 1) $I = 0$, 2) $I = 610\ A = 8.2I_c$.

it thin niobium wires, the contact dimensions being of the order of 10^{-4} cm. We have already used similar microcontacts earlier to investigate the dynamic intermediate state [8, 9]. The potential difference v between the sample and the wire was measured as a function of the current i through the wire at different values of I. We could also measure the quantity dv/di(i) with the aid of a device operating on a 15 kHz measuring current and having an amplifier with approximate sensitivity 10^{-7} V, and detect oscillations of dv/di with frequencies up to 1 kHz.

The v(i) characteristics of a normal sample ($T_c < T < 4.2°$) were linear, the resistance of the microcontacts r_n was of the order of $10^{-2} - 10^{-3}$ ohm, and changes of T and I did not influence r_n.

In the case of a superconducting sample ($T < T_c$, $I < I_c$), a section with $v = 0$ appeared on the v(i) curve, and a potential difference was produced at $i > i_c(T)$ (curve 1 of Fig. 2). At $I > I_c$ (we went high as $I \sim 10I_c$), the characteristics obtained at $0 < i < i_1(I)$ (where $i_1 < i_c$) retained a section on which we were unable to observe deviations of v from zero (curve 2 of Fig. 2), thus evidencing the high conductivity of the surface layer. The characteristics varied with the microcontacts, but the indicated features could be traced in all cases.

We observed no temporal variations of the v(i) characteristics, although if the usual moving structure of the dynamic state were to exist on the surface, such oscillations would certainly be detected at a frequency lower than 1 kHz. Several jumps of v from zero to $r_n i$ and back were usually observed after the generator was stopped, and were due to the surface drifting of residual n-phase sections which no longer had an axially-symmetrical arrangement.

In our opinion, the foregoing observations show that the mixed surface state of a superconductor of the first kind is stable and is produced on the internal surface of a current-carrying hollow cylindrical sample. Similar conditions can be produced also in other configuration, for example on the outer surface of the same cylinder if a coaxial conductor with current -I is placed in its cavity, etc.

It can be assumed that regularly disposed inhomogeneities with dimensions on the order of the layer thickness exist in the layer. These, like the structures of intermediate state in indium [6], should move with the same velocity as the electron drift in the layer (on the order of 10^2 cm/sec).

For a further study of the properties of the mixed-state layer, we are planning to measure its surface impedance and to search for electromagnetic radiation which may be emitted by this layer.

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TURNING OF THE SUBLATTICES OF A FERRIMAGNET IN A MAGNETIC FIELD

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In ferrimagnets with two sublattices, the relative orientation of the sublattices changes from antiparallel to parallel in a certain magnetic field interval ($H_1 < H < H_2$) [1 - 3]. In rare-earth iron garnets (RIG), owing to the strong paraprocess, the turning of the sublattices has a number of peculiarities. In these garnets, a strong exchange interaction takes place inside the resultant iron sublattices, a relatively weak interaction between the iron and rare-earth sublattices, and a very weak interaction between the rare-earth ions. At sufficiently high temperatures ($T \gtrsim 10^{\circ}K$) the latter interaction has no influence on the magnetic properties of the RIG, and consequently the rare-earth ions behave then like a "gas" of paramagnetic ions under the influence of the effective magnetic field produced by the resultant iron sublattice. The magnetization of the rare-earth sublattice and the critical fields H_1 and H_2 between which the turning of the sublattices takes place are therefore strongly dependent on the temperature. Thus, according to [1 - 3], $H_1 \sim 5 \times 10^5$ Oe in RIG at low temperatures, but decreases to zero in the region of the compensation temperature T_c, where the magnetizations M_1 and M_2 of the rare-earth and iron sublattices become comparable. The temperature region near T_c is of greatest experimental interest, but the results of [1 - 3] do not hold for them, since no account is taken there of the magnetic anisotropy, which plays the